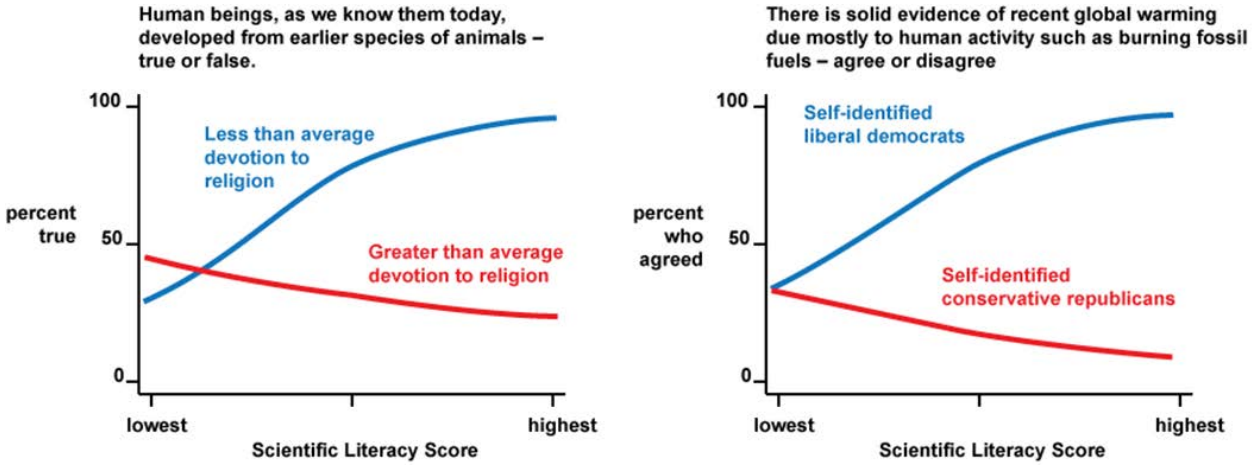
BIOC 122 – Biology for Voters

Spring 2020 Course learning goals

Our overarching learning goal is to become an informed voter in areas related to science and especially to biology. An informed voter should be able to set personal bias aside and make informed, rational decisions concerning political and social issues.

To what extent does personal bias influence our opinions? Consider the responses to the statements at the top of the two figures reproduced below[1]. Scientific literacy was measured by percentage of correct answers to questions such as "electrons are smaller than atoms – true or false." Perhaps surprisingly, the greatest differences were among individuals who were most scientifically literate.



[1]Redrawn from: Kahan, Dan M. Climate-Science Communication and the *Measurement Problem*. *Advances in Political Psychology*, 20 Feb 2015. DOI: 10.1111/pops.12244

Without taking a stance on who is "right" or "wrong," we can conclude that a significant percentage of voters do not understand the process of science, do not have a sound knowledge of basic science, have difficulty identifying reliable sources of information, and/or do not or cannot employ objective reasoning as they develop an opinion on matters related to science.

Learning objectives

As you look over the learning objectives for this course, be cognizant of one objective that is not among them. You are not expected to submit to the orthodox viewpoint in any area. On the other hand, you will be expected to be able to defend your viewpoint regardless of the position that you take on a subject. You will have to defend the credibility of your sources and will be expected to present rational explanations that employ logical reasoning.

Objective 1: Develop a solid understanding of the process of science and an appreciation for the credibility of scientific research and theories

1. Be able to distinguish what is in the realm of science from what is not in the realm of science
2. Learn to apply skepticism of a scientist
3. Learn to distinguish scientific fact from fiction, theory from conjecture, valid from spurious arguments, and to distinguish truth from myth or misconceptions
4. Be able to correctly explain what is mean by a scientific theory
5. Be able to distinguish what a theory claims from what it does not claim
6. Be able to cite examples of the slow, deliberate, progressive nature of science

Objective 2: Obtain a working knowledge of fundamental concepts in biology

1. Learn the roles of macromolecules and organelles in the function of living cells, and the roles of cells, tissues, and organs in the function and survival of living organisms.
2. Be able to explain the role of evolution, especially common ancestry and natural selection, in biology and biological research. *No concepts are more fundamental to biology than common ancestry and natural selection (i.e., evolution). Physical explanations for the formation of the universe, solar system, appearance of life on earth, and origin of species are common themes that will run throughout the course.*
3. Be able to explain the processes and consequences of gene expression, including how genetic information is stored, replicated, and inherited, how phenotype stems from gene expression, how genetic changes guide human development from egg to adult, and how gene expression can go awry, leading to cancers, immune deficiencies, etc.

Objective 3: Be able to recognize and access credible sources of information in biological and biomedical science

1. Be able to conduct a productive search for reliable information using the internet
2. Be able to distinguish reliable from less credible internet sources, cite evidence, and defend your sources
3. Be able to access and read a peer-reviewed journal article

Objective 4: Be able to convincingly present a point of view orally, in writing, and/or by using visual aids

1. Prepare and conduct an oral presentation that accurately and effectively presents a scientific topic to a lay audience, including support materials such as a PowerPoint slide show, handouts, posters, models, etc., as needed
2. Provide informative answers to questions from an audience, and
    - be prepared to challenge spurious claims and arguments that misrepresent scientific concepts and/or the process of science
    - be prepared to explain how evidence led to an explanation
    - be able to explain the faulty reasoning behind myths and misconceptions surrounding a explanation, including scientific theories
3. Respect the views of others and refrain from uncivil behavior, no matter how passionate you are about the subject.

Note to prospective BioSciences majors

In addition to the learning goals listed above, an objective of this course is to encourage students with strong interests in biology to consider a major in BioSciences. If you decide to pursue the major you will need to take Introductory Biology (BIOC 201). BIOC 122 is good preparation but is not a substitute for BIOC 201.

Policies, Topics, and Activities for Spring 2020

NOTE: This course syllabus is a work in progress, pending information on class size and student input on special topics to be covered. This syllabus subject to change at any time, with adequate notice.

Much of the learning in this course will take place in class, mostly through group work and discussions. Much of the learning will also take place as you prepare for class. There will be some lecturing, but this is not a traditional lecture course, and we do not use a textbook.

Instructor and office hours

Instructor: David R. Caprette, Ph.D.
Teaching Professor, BioSciences
Office and contact information: HBH 08B (Herman Brown Hall basement), caprette@rice.edu, x3498
Office hours are posted HERE; please check before you commit - I may have to reschedule around meetings and such

Schedule

BIOC 122 will meet Tuesdays and Thursdays from 10:50 am to 12:05 pm in RZR 119.

Topics

The course and assignment schedule is a work in progress and the dates are approximate. How fast we go depends on long our discussions take on each topic. You also have the opportunity to suggest additional topics, and I will fit them in if I can. PowerPoint slides will be posted in Files (folder: Spring 2020 slide sets) as pdfs following the corresponding class.

- Tuesday Jan 14 –
    - Preparation: see the assignments "Group behaviors" and "Scientists"
    - Introductions: students and instructor; introduction to active learning; introduction to Socrative; examples of mistrust of science (hazardous materials spill, Harry

Truman and the volcano); course learning objectives; group assignments; discussion - famous (and infamous?) scientists
    - Discussion: what topics would you like to explore in this course? [time permitting]
    - Slide set to be posted in Files: Intro.pdf
- Thursday Jan 16 –
    - Preparation: see the assignment "Evolution background"
    - [if not discussed last time] What topics would you like to explore in this course?
    - Science, pseudoscience, and just plain nonsense – how does science "work?"
    - Assessing the credibility of internet web sites
    - Slide set to be posted in Files: Science.pdf
- Tuesday Jan 21 –
    - Please complete the pre-class assessment before class today
    - Evidence for descent with modification (evolution)
    - Myths and misconceptions about evolution
    - Slide set to be posted in Files: Change.pdf
- Thursday Jan 23 –
    - Preparation: see the assignment "Natural selection background"
    - Discussion: websites on natural selection
    - What is the driving force behind descent with modification? What is the evidence to support Darwinian evolution?
    - How do we define fitness in a Darwinian sense?
    - What are some of the myths and misconceptions about natural selection and why are they myths/misconceptions?
    - Slide set to be posted in Files: Fitness.pdf
- Tuesday Jan 28 –
    - Preparation and on-line assignment: Case studies (including individual case assignments)
    - Discuss the case studies & questions
- Thursday Jan 30 –
    - Preparation: complete the assignment "Exam 1" by class time
    - First "mini-exam" (30 min) - process of science, evidence for descent with modification and natural selection, principles of natural selection and case studies; **see "Exam1_prep.pdf" in Prep guides (Files) for study suggestions**
    - Can Darwin's theory of natural selection explain altruistic behavior?
    - Slide set to be posted in Files: Altruism.pdf
- Tuesday Feb 4 –
    - Preparation: complete the assignment "Elements" by class time
    - Where did it all come from? Theory combined with informed speculation on the "origin of everything" and how conditions compatible with life in our Universe came to be
    - Slide set to be posted in Files: Origins1.pdf
- Thursday Feb 6 –
    - Preparation: complete the assignment "States of matter" by class time
    - Why do we look for water when we look for life elsewhere in the solar system or for extra-solar life?

    - Slide set to be posted in Files: Sixty_percent.pdf
- Tuesday Feb 11 –
    - Preparation and on-line assignment: "Biological molecules" (macromolecules.pdf in Files)
    - Workshop on biomolecules; begin Origins pt. 2 – could life have spontaneously arisen on earth? Some models for an abiotic origin

SPRING RECESS

- Tuesday Feb 18 –
    - Preparation: Assignment "Biomass" (see questions at the end of macromolecules.pdf)
    - Preparation: Assignment "Organelle functions" (see the Elite 8 document in Files)
    - Where did Earth's oxygen come from, origin of chloroplasts, mitochondria, and just what do chloroplasts and mitochondria "do?"
    - Build a model of ATP synthase
    - Slide set to be posted in Files: Origins2.pdf
- Thursday Feb 20 –
    - Bacteria and viruses; are we in danger of running out of antibiotics; how can we slow the inevitable path to becoming defenseless against "hostile" bacteria?
    - Slide set to be posted in Files: Resistance_is_futile.pdf
- Tuesday Feb 25 –
    - Preparation: complete the assignment "Exam 2" by class time
    - Second "mini-exam" (30 min) - Evolution of altruistic behavior, origin of everything & conditions required for life, water and biological molecules, origins pt. 2 up to aerobic metabolism (slide 50); **see "Exam2_prep.pdf" in Prep guides (Files) for study suggestions**
    - To vaccinate or not to vaccinate –vaccination, scientific fraud and its consequences, case studies related to the "vaccination controversy"
    - Slide set to be posted in Files: Vaccines.pdf
- Thursday Feb 27 –
    - Preparation: Assignment "Mitosis and meiosis"
    - Finish vaccination case studies, if necessary
    - Begin "Sex part 1" When does life begin? Or, maybe, when does a new individual really become human? We'll start to look at fertilization and early human development, plus some background on birth control, and and an early somatic cell mutation
- Tuesday Mar 3 –
    - Finish "Sex part 1," begin "Sex part 2
    - Slide set to be posted in Files: Sex1.pdf

- Thursday Mar 5 –
    - Preparation: Assignment "Gender"
    - "Sex part 2" – In what ways can development go wrong? What happens when meiosis goes wrong? Some consequences of abnormal gastrulation, aneuoploidy (abnormal distribution of chromosomes); begin part 3

    - Slide set to be posted in Files: Sex2.pdf
- Tuesday Mar 10 –
    - Now to finish "Sex part 3" – Men are men and women are women – except when they aren't! Biological sex isn't as simple as some people think
    - Animals in teaching and research
    - Slide sets to be posted in Files: Sex3.pdf; Animal_research
- Thursday Mar 12 –
    - Preparation: complete the assignment "Exam 3" by class time
    - "Mini-exam #3 – Bacteria, viruses, and vaccination, Sex parts 1-3; **see "Exam3_prep.pdf" in Prep guides (Files) for study suggestions**
    - Exploring the human brain; biology behind learning and memory, perception, happiness, pain and addiction
    - Slide set to be posted in Files: Brain.pdf

SPRING BREAK

- Tuesday Mar 24 –
    - Preparation: internet research into bone, blood and the circulation (see Bone_blood.pdf in Files)
    - Bone, blood, and the circulation (what do they all have in common?)
    - Slide set to be posted in Files: Blood_n_bone.pdf
- Thursday Mar 26 –
    - Preparation: Introduction to gene expression (please give yourself plenty of time for this one)
    - Control of gene expression – how the environment can influence phenotype
    - Slide set to be posted in Files: Altitude.pdf
- Tuesday Mar 31 –
    - Epigenetics – maybe Lamarck wasn't that far off after all!
    - Slide set to be posted in Files: Epigenetics.pdf
- Thursday Apr 2 –
    - Preparation: Mutations and human pedigrees
    - Human genetic disorders and their inheritancef
- Tuesday Apr 7 –
    - Preparation: complete the assignment "Exam 4" by class time
    - "Mini-exam" #4 – Animals in research/teaching, gene expression, epigenetics, human genetic disorders and their inheritance; **see "Exam4_prep.pdf" in Prep guides (Files) for study suggestions**
    - Finish human genetic disorders and their inheritance
    - Slide set to be posted in Files: Pedigrees.pd
- Thursday Apr 9 –
    - "Misbehaving genes" – Tissue regeneration and cloning; biology of cancer; dare we "resurrect" extinct animals?
    - Slide set to be posted in FIles: Cancer_cloning.pdf
- Tuesday Apr 14 –
    - Preparation: gene editing preparation

    - Introduction to gene editing & CRISPR – Eugenics? Designer babies? Are genome editing and CRISPR leading us toward a race of "super humans?"
    - Slide set to be posted in FIles: Gene_editing.pdf
- Thursday Apr 16 –
    - Genetically modified organisms (GMOs) – should we be concerned?
    - Slide set to be posted in FIles: GMOs.pdf
- Tuesday Apr 21 –
    - Personal genomics – What surprises might be in store in your very own DNA? Who are you, really, and where did you come from? What crazy stuff can we do with DNA testing
    - Slide sets to be posted in Files: Personal_genomics.pdf; Belyaev's_pets.pdf

- Thursday Apr 23 –
    - RSVP -*This last class is optional. No exam question will stem from the microscope lab. I ask that you complete the survey so that I know who is coming; I have limited space.*
    - What is a biology course without at least one lab class? Welcome to the microscope lab!

~ FINAL EXAM: Pt. 1 on line due Apr 30; Pt 2 in person TBA ~

~See the file Final_exam_prep in Prep guides (Files) for study suggestions~

Honor code policy

Unless otherwise indicated, assignments are "open resource" and "open to collaboration among members of your group." Otherwise, any restrictions will be identified at the beginning of the assignment description and announced in class. Open resource means that students may have access to their notes, posted resources, internet, texts, library materials, and any other reference materials while working on an assignment. Open to collaboration among members of your group means that you are encouraged to work on an assignment with others in your assigned study group but must not seek help from other individuals.

Every final product must be prepared in your own words – you are not to plagiarize. For example, you must not simply quote directly from web sites. Please consult the document on academic integrity that I've posted in Resources if you are not sure what constitutes acceptable behavior.

Absences, late arrivals, and late assignments. The honor code applies to requests to be excused from participation or for permission to submit an assignment late. Legitimate excuses for missing class include circumstances beyond your control such as illness, death in the family, travel for athletics, graduate school interviews, etc. Students arriving late to class without an acceptable excuse will receive partial credit for attendance. Any student experiencing a problem submitting an assignment must contact the instructor immediately. Ten percent of the available score will be deducted per day an assignment is late. If you know in advance of a planned activity that will take you out of class, you are expected to notify the instructor as soon as you are aware of the

activity. This requirement includes activities that are on your schedule at the beginning of the semester.

Learning activities

In class we will conduct presentations, group discussions, and hands-on activities. To promote full participation in class and to avoid distractions, the instructor may ask you to silence or shut off electronic devices and/or to keep your laptops closed.

Every pre-class preparation assignment, day's participation, and minute question (see below) counts equally toward your learning activity score subject to instructor override, if applicable.

Pre-class preparation. Many classes will require completing some sort of pre-class assignment, either individually or as a group. Assignments may include online quizzes, which may or may not be graded. Graded assignments will be identified as such.

- You will receive full credit for a pre-class assignment if you complete the work and attend the corresponding class
- If you complete a pre-class assignment but miss the corresponding class, then the assignment will not count toward your course grade
- If you fail to complete an individual pre-class assignment or your part of a group assignment, a zero will be recorded

Participation. Your on-time attendance and full participation in class activities are essential. You will receive a score of 100% for each day that you arrive in class on time and give the class your full attention and effort.

Instructor override. I may modify your participation grade based upon your level of engagement in the class. I might override a low participation score for a student who misses an assignment or two but is otherwise enthusiastic about the class and contributes significantly to its success. I may also have to reduce a participation score for any student who detracts from the success of the course.

Exams

Each midterm "mini-exams" will be given at the beginning of class and you will have up to 30 min to complete them.There will also be a cumulative final exam.

Missed exams. Without an acceptable excuse, a score of zero will be recorded for any missed exam. Only circumstances that are beyond your control are considered acceptable excuses. If you know in advance that you will miss an exam then please provide at least a week's notice. Otherwise please notify me as soon as you become aware of the conflict. In most such cases you may take the exam early at an alternative time and place. I reserve the option of providing a different makeup exam. Only in the case of a sudden illness, family emergency, or other unexpected event will a makeup exam be given without advance notice.

Students with disabilities

Any student with a documented disability needing adjustments or accommodations is requested to speak with the course coordinator during the first two weeks of class. All discussions will remain confidential. Such students should also contact Disability Support Services in the Ley Student Center.

Course grade

Please check the gradebook frequently and report any errors or omissions. The breakdown of your course grade will be as follows:

- Learning activities, 10%
- Midterm exams, 60%
- Final exam, 30%

Grade cutoffs are as follows: ≥ 97% = A+; 93-97 = A; 90-93 = A-; 87-90 = B+; 83-87 = B; 80-83 = B; 77-80 = C+; 73-77 = C; 70-73 = C-; 67-70 = D+; 63-67 = D; 60-63